
# Potential Impacts from the Yannarie Solar Salt Project on the Exmouth Gulf

## ERMP Response from Halt the Salt Organisation

**REV 0**

# CONTENTS

# EXECUTIVE SUMMARY

## The Proposal

Straits Resources proposes to construct 411 square kilometres of evaporative 'solar' salt ponds across the discharge of the Yannarie wetland system located on the eastern shore of Exmouth Gulf. A complex system of rock retaining walls would extend 70 km and essentially occupy the entire eastern coast of Exmouth Gulf.

## Significance of the East Coast of Exmouth Gulf

The eastern side of Exmouth Gulf, including the supra-tidal flats, has been identified as a environmentally significant area warranting special conservation measures (including World Heritage nomination) by a range of agencies / planning committees.

The Directory of Important Wetlands of Australia lists nationally important wetlands. The east coast of Exmouth Gulf is listed in this directory as "*an outstanding example of the tidal wetland systems of low coast of north west Australia, with well developed tidal creeks, extensive mangrove swamps and broad saline coastal flats*." The listing is based upon satisfying three of six selection criteria, namely:

1. It is a good example of a wetland type occurring within a biogeographic region in Australia.
2. It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
3. It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.

## Unacceptable Destruction of High Value Conservation Area

The scale proposal is unprecedentedly large and will provide an unacceptable barrier between the coast and the hinterland. The solar salt industry is not sufficiently lucrative to justify the scale of the proposal and associated environmental risks. Existing West Australian solar salt operations have already significantly altered large sections of the WA coastline and have shown to be not sustainable developments.

In the ERMP, the proponent has attempted to downplay and misrepresent the significance of the area and the potential impacts of the project through promulgation of the hypothesis that the supra-tidal flats are a "vacant ecosystem". The proponent infers that terrigenous inputs are unimportant for maintaining the high biological productivity of the Gulf. This position is not supported by measures of biological productivity following rainfall events.

The proponent has not addressed the significance of the Yannarie Wetland System (including the supra-tidal flats) as a geoheritage, global heritage, or the landscape importance of the area, and has not seen the total picture of what constitutes a delta. The solar salt project will partly destroy the globally unique and important Yannarie River delta system, and destroy part of the proposed World Heritage site.

## Unacceptable Hydrological Impacts

The ERMP analysis of the local hydrogeology has many errors and uninterpretable items that do not give confidence in the conclusions, particularly on the correct application of modelling tools.

The basis of the hydrology and the understanding of the hydrodynamics in groundwater rest on a proper understanding of the stratigraphy, however the stratigraphy in the ERMP is poorly described, misleading, and erroneous.

The development of a supersaline water body in the evaporation ponds, with a relatively high hydraulic head, will result in seepage plumes of dense saline water into the underlying sediments, which will discharge seawards emerging from under the tidal flats. East Exmouth Gulf *will provide the first location in tropical Western Australia where a continuous fringe of mangroves will intersect the supersaline water discharge (essentially an effluent) from proposed*

*salt ponds, and where there also is an inherent natural stratigraphy that will result in the delivery of the saline plume to the tidal flats, their benthos, and their dependent biota (such as the fishery and prawns)*. The discharge will fundamentally alter the ecosystem of the tidal flats, from a microbiological perspective, and from macrobiota such as invertebrate fauna and mangroves.

The use of the Bruun Rule for muddy shorelines is invalid and meaningless and therefore the proponent's analysis with respect to the environmental impacts of their positioning of the seawall barrier would appear to be flawed.

**Lack of Information on Impacts**

The proposal to address bitterns handling/recovery and impacts until after the project has been assessed by the EPA is unacceptable since this likely constitutes the biggest environmental consequence of the project upon the nursery areas and clean waters of Exmouth Gulf.

The ERMP information provided in relation to fisheries productivity fails to provide an adequate basis for assessing the environment impacts of the proposal. In particular the ERMP lacks:

- A sophisticated spatial model of the hydrology and local water movement patterns throughout the Gulf;
- The mapping of the benthic primary producers (including both algal mats and seagrass) along the east coast, and the relation of their distribution to juvenile prawn abundance; and
- A prediction of the effects of cyclone events and the related tidal surges on the intertidal and supra tidal zones of the Eastern Gulf.

There are many other unacceptable issues with Strait's proposal which have been detailed in this submission of the Halt the Salt Alliance. They concern, amongst others, the impacts from salt water intake pumps, introduction of non-indigenous marine pest species, acid sulphate soil disturbance and impacts upon marine fauna and stygofauna.

**Conclusion**

The report on the Yannarie Salt Project Environmental Review and Management Programme has flaws at several levels of which the most serious are the lack of application and use of appropriate scientific evidence / models and the understanding of the ecosystem processes. This development will damage and likely destroy an entire sub-regional scale ecosystem and environmentally significant area of national importance thereby damaging sustainable commercial and recreational fisheries dependent on Exmouth Gulf as well as other natural, economic and commercial values of Exmouth Gulf. The ERMP has not proven that the project is an Ecologically Sustainable Development and should therefore be rejected.

# 1 PROJECT BACKGROUND

Straits Salt Pty Ltd (Straits) is proposing to construct and operate a nominal 10 million tonne per annum (Mtpa) solar saltfield on the eastern margin of the Exmouth Gulf (the Gulf) in Western Australia, known as the Yannarie Solar Project.

An Environmental Review and Management Programme (ERMP) for the Yannarie Solar Project has been prepared in accordance with administrative procedures under Part IV of the Environmental Protection Act, 1986. The Environmental Protection Authority (EPA) has released the ERMP on 4 December 2006 for public comment until 26 February 2007, with a late revised submission date of 12 March 2007.

Additional information about:

- Flora and vegetation;
- Subterranean fauna; and
- Subtidal benthic communities.

will be published in the first half of 2007. These supplementary reports will be made available for a further four (4) week public submission period.

## 1.1 Scope

The purpose of this document is to present the submissions from organisations on behalf of the key alliance members of the 'Halt the Salt' campaign, which constitutes of:

- Conservation Council of Western Australia
- M.G. Kailis Group
- Recfishwest
- Western Australian Fishing Industry Council (WAFIC)
- Pearl producers Association
- North West Research Association
- Cape Conservation Group
- Australian Conservation Foundation
- Recfish Australia
- Australian Council of Prawn Fisheries

The submissions are from the following four organisations:

- MG Kailis to report on behalf of the Western Australian Fishing Industry Council (WAFIC) for the prawning industry in the Exmouth Gulf;
- Pearl Producers Association (PPA) for the pearling industry in the Gulf;
- RECFISHWEST for recreational fishing in the Exmouth Gulf; and
- Conservation Council of Western Australia for the coastal conservation of the region.

The Halt the Salt Alliance has been supported by several independent scientists who have provided their expert opinion on the Yannarie Solar project. Their contributions have been added as appendices to this report.

## 1.2 Abbreviations

| | |
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| ANC | Acid neutralising capacity |
| AQIS | Australian Quarantine and Inspection Service |
| ARI | Annual recurrence interval |
| ASS | Acid Sulphate Soils |
| DoE | Department of Environment |
| EPA | Environmental Protection Authority |
| ERMP | Environmental Review and Management Programme |
| HtS | Halt the Salt (Organisation and Campaign) |
| IMO | International Maritime Organisation |
| IMS | Invasive Marine Species |
| MPRSWG | Marine Parks & Reserves Selection Working Group |
| Mpta | Million tonne per annum |
| NIMS | Non-Indigenous Marine Species |
| PPA | Pearl Producers Association |
| WAFIC | Western Australian Fishing Industry Council |

# 2 COMMERCIAL FISHING – PRAWNING INDUSTRY

**www.kailis.com.au**

| | |
|---|---|
| Address: | Level 1,<br>46 Mews Road<br>Fremantle, WA 6160 |
| Telephone: | 61 8 9239 9304 |
| Fax: | 61 8 9239 9204 (trading) |
| | 61 8 9239 9222 (general) |
| Postal Address: | Locked Bag 6700<br>Fremantle WA, 6959 |
| Email address: | StephenHood@kailis.com.au |

**www.wafic.org.au**

| | |
|---|---|
| Address: | Suite 6<br>41 Walters Drive<br>Osborne Park, WA 6017 |
| Telephone: | +61 08 9492 8888 |
| Fax: | +61 08 9244 2934 |
| Postal Address: | PO Box 55,<br>Mt Hawthorn, WA 6915 |
| Email address: | wafic@wafic.org.au |

## 2.1 Introduction

Exmouth Gulf supports a long-standing sustainable prawn trawl fishery which provides Tiger Prawns, Exmouth King Prawns and Endeavour Prawns to the Perth market. The 16 licences in the fishery are operated by 12 boats and harvest on average 1000 tonnes of prawns every year whilst providing employment for over 100 people and producing in excess of $15 million in revenue.

The Yannarie mangrove system on the eastern side of Exmouth Gulf is a vital nursery for crustaceans and fish, including species utilised by significant commercial and recreational fisheries established in the region. This area has therefore been universally recognised as requiring a high level of protection. In particular, both the well established prawning and pearling industry in the Gulf relies on this nursery for their future operation.

The prawn fishery is known to be dependent on juvenile recruitment from the shallow seagrass and algal beds on the eastern side of the gulf. Regular pulses of nutrients enrich these seagrass beds following outflows from the hinterland after cyclonic rainfall, or heavy winter rains. Studies of these seagrass beds following the impacts of cyclone Vance in March 1999, demonstrate the reliance of these nursery areas on terrestrial nutrient run-off (Appendix E).

The fishery is closely monitored by WA Fisheries research staff and is managed cooperatively by the Fisheries Department and industry based on real-time information supplied by the world's leading technology. The fishery is often quoted as the "best managed" prawn fishery in the world.

The Exmouth region is also home to a pearl oyster fishery and grow-out industry and an established recreational / sports fishery.

Both fishing and aquaculture are highly dependent on the maintenance of high water quality and the natural ecological processes which drive marine productivity. All these activities will be threatened by the proposed Yannarie Salt Project.

The production and transfer of juvenile pearl oysters to important pearl farm areas in the Kimberley is dependent on freedom from exotic disease and pests. The presence of large bulk carriers from high risk areas puts the disease-free status of stock from what the Government has declared as an “icon industry” in WA at definite risk.

Mangrove forests are one of the world’s most threathened tropical ecosystems with global loss exceeding 35%. Mangrove deforestation due to the proposal is likely to have severe deleterious consequences for the Exmouth Gulf ecosystem function and thus biodiversity and fisheries productivity (Mumby *et al*, 2004) .

Both commercial and recreational fisheries will potentially see a reduction in recruitment as a consequence of change to habitat structure and foodwebs resulting from the construction of the solar salt complex. Vast numbers of larvae and juveniles will also be directly removed from the nursery habitat by the water intake pumps.

The presence of an industrial port and shipping operation may also result in the exclusion of both commercial and recreational fishers from important fishing areas.

## 2.2 Summary of Major Concerns

The following topics have been identified as the major threats to the commercial prawning industry in the Exmouth Gulf due to the salt production proposal and are discussed in further detail in Section 2.3.

- Impacts from alteration of surface water flows (loss of productivity - ecosystem and fishery related by diversion of fresh-water runoff containing nutrients in heavy rainfall events);
- Impacts on groundwater and mangroves;
- Impacts from bitterns management (disposal of bitterns despite a commitment to use and accidental loss of bitterns);
- Impacts from water intake pumps (entrapment of juvenile prawns, loss of nursery area);
- Introduction of non-indigenous marine species through ballast water/hull fouling;
- Loss of mangroves/algal mats through sea-level rise;
- Impacts from barge harbour dredging / acid sulphate soils;
- Fisheries assessment based on inadequate information; and
- Scale and timeframe.

## 2.3 Response to Relevant ERMP Sections

### 2.3.1 Impacts from alteration of surface water flows

The project proposes the construction of rock retaining walls stretching more than 70 km along the east coast of the Exmouth Gulf and diverting the natural 'flood-out' drainage pattern and terrestrial run-off from storm surge events in the area. Although modelling indicated that no significant runoff occurs in the Yannarie and Rouse systems from the by-annual and annual recurrence interval (ARI) rainfall events, it was admitted that these watercourses are very complex systems and that the modelling was not completely accurate.

By constructing a diversion dam for flood protection from the Yannarie River system, retained water will deposit nutrients and sediments before reaching storm surge affected areas thereby depleting the mangrove, algal mat and nearshore habitats from nutrient influx.

Storm surges leading to higher sea levels transgressing onto the supratidal salt flat will return accumulated sediment and nutrients to the coastal areas. Since this is an infrequent occurrence, small flushes of storm surges which occur more frequently are potentially an important event for maintaining/replenishing the nutrient health status for the nursery habitat and sediment status of the estuaries extending along the eastern coast of the Gulf. The ERMP catchment modelling however did not continue close enough to the coast to show flows from sub-catchments near the shore in smaller events. The proposed barrier and in fact the whole project could drastically alter heavy rain and both small and large storm surge effects in Exmouth Gulf, potentially degrading much of the Gulf's east shore ecosystem through alteration of storm frequency run-off, cyclone impact area and local rainfall events.

### 2.3.2 Impacts on groundwater and mangroves

Large scale mangrove mortalities have been shown to be associated with the formation of concentrator ponds in Port Hedland. The ponds were constructed in mid 1990s and significant mangrove mortalities (many hectares) were still found to be occurring in 2005, some more than 1km from the bund wall. The cause of the mangrove impacts has been found to be as follows:

a. The hydrostatic head formed by the impoundment of water on top of the naturally occurring hypersaline groundwater of the supratidal salt flats to migrate towards the coast. Due to the low hydraulic conductivities of the mud underlying the salt flats, the plume migrates at a slow rate;

b. The salinity in the plume is too high to support mangroves and mortalities occur at the landward edge of the mangrove zone and the terminal portions of tidal creeks where groundwater is less influenced by tidal variations; and

c. Bore logs kept over more than 10 years provide a clear record of this process.

The proponent fails to take the learnings from other saltfields such as Port Hedland into consideration, and downplays the potential for seepage due to the underlying clays and distance of the ponds from the mangroves.

Given the scale of the project the geotechnical investigations were inadequate and assumptions of uniformity along the entire 75 km are unfounded.

The potential for groundwater salinity impacts on algal mats were not addressed.

### 2.3.3 Impacts from bitterns management

The proposed operation will involve the impoundment of vast quantities of toxic bitterns. The proponent claims that it will store the bitterns until such time as new technology becomes available to prohibit discharge from occurring. However, the proponent fails to give adequate information on the following:

- The volume of bitterns to be stored;
- The location of the storage; and
- The management of potential environmental impacts from storage.

If not stored properly, this material could enter the Gulf ecosystem through seepage, wall failure or natural disaster events, potentially affecting mangrove and algal mat systems as well as marine fauna. Furthermore, at what time will it be decided that the storage capacity is full and discharge of bitterns is required?

Discharge of bitterns into Exmouth Gulf would pose a highly significant environmental stress on the ecosystem for the following reasons (from confidential source):

a. Preliminary ecotoxicity testing of bitterns suggests ecological effects at dilutions of more than 100 fold, even when diluted with surrounding water;

b. Toxic effects are likely related to difference in ionic composition of bitterns to seawater, with concentrations of magnesium in bitterns of around 70,000 mg/L in contrast to background concentrations of around 1,400 mg/L;

c. Field studies in Nickol Bay and Port Hedland have shown that bitterns will flow away from discharge points as a poorly mixed hypersaline layer unless mixing is achieved by strong spring tidal currents associated with tidal variations of more than 2m;

d. During neap tides poor dilution results in pooling of toxic concentrations of bitterns in nearshore waters and spring tides move the partially diluted plume kilometres away from the discharge point;

e. Exmouth tidal variation (<2m during spring tides) is less than that of the more northerly salt field locations and so mixing can be expected to be less;

f. Poorly mixed discharge from Yannarie salt fields would flow down the bathymetric gradient to the deeper areas of Exmouth Gulf which currently support the prawning industry; and

g. Mixing close to shore would result in shallow seagrass nursery areas being subject to potentially toxic concentrations of bitterns.

In addition, other equipment/machinery will be required for processing the bitterns which could lead to supplementary environmental impacts. This only adds further doubt and speculation that this idea is not proven to be an environmentally sustainable solution.

We therefore challenge the notion of "beneficial outcomes for the environment" as stated in Chapter 2, Section 1 of the ERMP.

### 2.3.4 Impacts from water intake pumps

Straits' proposal involves the extraction of significant quantities of seawater via two or more massive intake pump stations in two creeks which will be pumping for an average of 14 hours a day. The water intake chambers will be designed with screens to avoid intake of floating debris and mega fauna. The ERMP states that there is a reasonable risk of siltation in Naughton Creek and that the combination of high pumping rates and the existing tidal fluxes will result in a significant change of the creek water flows. Furthermore, excavation of the seabed is required and the soils are potentially acid sulphate generating.

The design of these pumps and the pumping rates do not take into consideration that juvenile prawns, fish larvae and post-larval fishes use these creeks and coastal areas up to a depth of 5 to 8 m. The banana and greasyback prawns especially, move substantial distances inshore with the tides (Vance et. al. 2002) and will therefore be substantially affected by the shallow water intake in the creek areas. Not only will juvenile fauna entering the intakes be damaged and resulting in significant mortality rates, but the changes in hydrodynamics will substantially alter the salinity gradients within the creeks thereby altering the suitability and availability of habitats to the prawns. The proponent has not demonstrated that these concerns are adequately addressed in the design through comprehensive intake modelling. In addition, the level of mortality must be quantified, and measures be put in place to reduce these to within adequate levels.

The nursery area is of vital importance to the Gulf ecosystem and to the commercial fisheries. The area is presently completely closed to trawling and has been proposed as a marine conservation reserve under the Conservation and Land Management Act, 1984 as well as a fish habitat protection area under the Fish Resources Management Act, 1994. Straits' proposal fails to quantify the impact that the massive water intake of 506 million $m^3$/year will have on the prawn and fish nursery areas in the creeks and wider surrounding area. The draw-down of water is likely to create a large area where nursery stock is being continuously depleted and saline gradients are altered, which will impact upon the vitality of the ecosystem, the commercial fisheries and Exmouth economy.

The management of entrapment of marine life when pumping seawater (as stated in Chapter 6, Section 3.4.5 of the ERMP) contradicts principles of good practice. The Marine Management Plan (Volume 2, Chapter 3) states that biota baseline surveys will be undertaken to determine impacts of seawater pumps. The ERMP states that Straits will assess the extent and rate of entrapment once production has commenced. It is not acceptable to carry out baseline surveys and assess impacts after the ERMP has been submitted nor is it acceptable to only manage the seawater intake effects upon fish species. The banana prawn species in Exmouth Gulf are likely to be most affected by the water intake pumps since they use small tidal creeks and gutters that drain mangrove forests at low tides and the mangrove forests at high tides (Appendix A).

Prawn larvae are able to survive in hyper saline water (50-60 ppt) where some of their predators can not. Drawing water flows into the creeks from the deeper gulf area will change salinity levels and thereby allow prawn larvae predators to enter formerly uninhabitable areas, essentially eradicating the nursery grounds.

The proposed 'management' will address impacts after they have occurred instead of trying to anticipate and prevent adverse impacts. The 'management' will be too late for the nursery and ecosystem as a large area would be depleted of juvenile fauna and salinity levels will be altered, rendering a large area unsuitable as nursery habitat. It is not a sustainable management strategy to wait until damage has been done in order to 'fix' the problem, if this is possible at all. No initiative has been included in the ERMP with possible solutions for minimising or resolving the issue of entrapment of vital juvenile fauna. This issue should have been addressed prior through modelling and from experiences with other salt fields with regards to impact on areas of water intake points.

### 2.3.5 Introduction of non-indigenous marine species (NIMS) through ballast water / hull fouling

The ERMP states that allowance is made for multiple anchorage / loading locations. The proponent estimates that with 3,000,000 tonnes of salt production, 40-50 ships up to 65,000 tonnes will be loaded annually This is predicted to increase to 120-150 ships at 10,000,000 tonnes salt production. The ERMP states that there will be up to three Panamax class container ships anchored in the Gulf at any one time, 19 barge loads will be required on average every week to fill these ships and 1 dredge vessel will be working at Hope Point for approximately 4 months.

This level of shipping activity within the Gulf will inevitably result in major impacts on the local ecosystems, as well as other activities including commercial and recreational fishing, tourism, whale watching, diving etc. In addition, marine pests have been introduced to Australia and moved around Australia (or translocated) by a variety of human and natural means. Transport opportunities for marine pests are, amongst others, through biofouling (hull growth of non-indigenous marine species (NIMS), anchor chains, and internal compartments of boats). Pests can also be transported in seawater systems of boats, including inside pipes and in bilge and ballast water or simply by drifting with ocean current movements. Risks are two-fold and include direct transfer from international shipping activity, as well as secondary transfer through local shipping activity between local ports, anchorages and other locations.

Once introduced to an area, the potential exists for marine pests to thrive, particularly where their origin has similar environmental conditions, and they do not face predators or competitors in their new environment. They can spread rapidly and may prey on, or compete with, native species, therefore affecting food chains. Marine pests can severely affect biodiversity, marine habitats and rare and endangered species.

Once established, introduced pests may have a significant impact on the local fisheries by potential impact on recruitment, competition for food and quarantine requirements resulting from outbreaks. This has been observed in numerous locations in Australia and elsewhere. The financial consequences potentially are devastating.

The substantial increase in the number of international ships anchoring and moving in the Gulf area poses a significant risk to the commercial fisheries and to the nursery area. The ERMP proposes to select multiple anchorage areas thus further increasing the risk by facilitating a more rapid spread of potential pest species. It is not sufficient to state that all ships will adhere to the International Maritime Organisation (IMO) guidelines, the Commonwealth Quarantine Act 2000 and Australian Quarantine and Inspection Service (AQIS) Ballast Water Management Requirements since the area is of high natural value and importance for the commercial fishery industry.

Moreover, unlike Australian Ballast Water regulations, the risk of introduced marine pests from hull fouling currently is not formally regulated under AQIS Requirements, so that this risk is even more difficult to manage and control.

The prawn fishery depends heavily upon the continuation of vegetation mosaics in the shallower waters on the east coast of Exmouth Gulf. Any changes in type and extend of vegetation have a direct impact upon the juvenile prawn population and thus the prawn fishery, as was shown by Cyclone Vance. Marine pests such as seaweeds and macro algae may change the nursery vegetation to the detriment of the dependent fauna.

The proponent should, as a minimum, have assessed which pest species have the greatest potential of becoming established and which have the ability to disrupt the nursery ecosystem and the commercial fisheries. The proponent should have detailed management plans and emergency response plans to the introduction of these marine pests and as well as described safeguards against these incursions.

### 2.3.6 Loss of mangroves / algal mats through sea-level rise

In Chapter 4 the proponent states that "*long-term sea-level rise in the Exmouth Gulf will not necessarily result in an inland migration of the mangrove system from its current position.*" This was based upon evidence from mangrove elevations in muddy coastal environments in south-west Florida which had kept pace with 10-20 cm sea-level rises from 1930 to 1990. Then, in Chapter 6 the proponent states that one of the key sediment study results was that "*sediment accumulations rates are extremely small (<1 m for the Holocene) and some of the intertidal mangroves and salt flat regions appear to be zones of erosion rather than deposition.*" When the proponent applied the Bruun Rule to locate their infrastructure on the supratidal salt flat, catering for a shoreline retreat of 38 m, it conveniently disregarded the sediment study results. Clearly the key sediment studies indicate that areas of mangroves are unlikely to elevate themselves through sediment deposition and therefore they likely get permanently flooded as sea levels rise and will die as a result. The possibility of Mangroves retreating further up the coast has been effectively cut off with the construction of the retaining wall (500-600 m between the wall and the mangroves). In addition, it is likely that the existing creek system will vanish as well due to alteration of the surface water flows. The project could therefore result in localised depletion of mangrove and algal mat systems with a consequent impact upon the nursery habitat. The ERMP fails to model the effect of mangrove death combined with storm surge / cyclone effects upon the salt fields. It is a likely outcome of the project that mangroves growing locally will die due to either acid sulphate soils (ASS), sea level rise, alteration of sediment deposition, salinity changes, fuel spills or a combination of these factors.

### 2.3.7 Impacts from barge harbour dredging / acid sulphate soils

All infrastructure proposed in the subsea and intertidal area of the Gulf will modify existing marine faunal habitats, again, to the detriment of prawns and other species using the area as a nursery and seagrass habitat which may also lead to loss of dugong feeding areas.

The silty bottom of the eastern side of the Exmouth Gulf is likely to be mobilised by repeated dredging operations, hence smothering marine benthic primary producer habitats.

The proponent states that the material to be excavated may be potentially acid generating and this is major cause for concern. The migration of acidity in soils moves metal elements, adversely affecting marine organisms and hence causing serious impacts on the prawn industry in the Exmouth Gulf (Appendix B).

The proponent also states that the volume of ASS is small compared with the total volume of material proposed to be removed. The amount of material to be excavated is in the order of 8 million $m^3$ and the "small" amount of potential moderate to high risk acid

generating excavation material is in the order of 1 million $m^3$ (as per the ASS Management Plan in Volume 2, Chapter 6), which could have severe impacts upon the local environment if not handled properly.

The Department of Environment (DoE) guideline on ASS (DoE. 2006) states that it "*has recent experience with a number of projects in Western Australia where the level of ASS management undertaken was reduced, because laboratory soil analyses indicated that the ASS materials in question had sufficient acid neutralising capacity (ANC) to render them self-neutralising. However, it was found that under real field conditions, disturbance of the soil profile did in fact result in the generation of significant acidity, with resultant environmental damage including release of heavy metals into groundwater and surface waters. Once this mobilisation of acidity and metals has occurred, it is very difficult, if not impossible, to reverse.*"

The soil testing by the proponent for the presence or absence of acid sulphate soils has to date concentrated on the water intake areas in the two creeks and the excavation area for the barge harbour. The results indicate that "*all samples were potential acid sulphate soils but their acidic neutralising capacity was in excess of their acid forming potential.*" The proponent also states that Parsons Brinkerhoff determined that the geomorphic zones of supratidal-intertidal boundary and the supratidal salt plain have moderate to high acid generating capacity potential and that an ASS Management Plan will undertake further sampling and address sediment handling and treatment.

The DoE guideline (DoE. 2006) states further that "*DoE considers that utilisation of ANC values without confirmatory field kinetic testing or modified laboratory methods cannot be used as an argument to reduce the level of management required for the disturbance of ASS*" and "*an ASS Dewatering Management Plan should still be developed for sites with potential sulfidic acidity in excess of Texture-Based Action Criteria, regardless of the outcome of the ANC testing*".

Since the barge harbour and excavation areas for the water intake pumps are found to be potentially acid sulphate generating and the DoE's guideline states that a dewatering management plan should be developed, the proponent's assessment and management proposal is totally inadequate with regards to identification of dredge material disposal impacts upon the mangrove, algal mat and marine nursery areas. Furthermore, other infrastructural works such as the building of the dams, wash plant and road areas on the supratidal salt flat are also likely to disturb soils which have been identified as having a moderate to high potential for generating ASS and for which no data is available in the ERMP.

It is certainly not good practice to say that investigation will take place, and the impacts will be dealt with after permission for the project has been granted by the government. It is highly probable that mobilisation of acidity and metals will occur during construction works. This would be detrimental to mangrove and algal mats and have an impact upon the marine nursery area and dependent fauna, in addition to reducing the values of the proposed marine conservation reserve, and fish habitat protection areas.

The ERMP states in Chapter 6 that the "implementation of the proposal poses only a minor risk to water and sediment quality in Exmouth Gulf". However, the proponent has not carried out an appropriate and thorough assessment of the impacts of ASS.

### 2.3.8 Fisheries assessment based on inadequate Information

The ERMP information provided in relation to fisheries productivity has been based on largely unsupported initial assessments thereby failing to provide an adequate basis for assessing the environment impacts of the proposal (see Appendix F). In particular the ERMP lacks:

- A sophisticated spatial model of the hydrology and local water movement patterns throughout the Gulf;

- The mapping of the benthic primary producers (including both algal mats and seagrass) along the east coast, and the relation of their distribution to juvenile prawn abundance; and
- A prediction of the effects of cyclone events and the related tidal surges on the intertidal and supra tidal zones of the Eastern Gulf.

### 2.3.9 Scale and timeframe

The EPA is requested to take into consideration that the scale proposal is unprecedentedly large and will form an unacceptable barrier between the coast and the hinterland for over 70 km. The only other solar salt field of comparable dimensions (by ESSA in Baja California, Mexico) to be proposed was not permitted to go ahead because of environmental concerns (Profepa, 1998).

Furthermore, the proposal fails to mention the expected timeline of operation and has no clear commitment during decommissioning of the facility to rehabilitate the area to its pristine state.

## 2.4 Conclusion

MG Kailis Group is extremely concerned with the Yannarie Solar proposal as outlined in the ERMP, and any large scale development along the eastern side of Exmouth Gulf. The proposed project is not a sustainable long term development as it will alter and have long term detrimental effects upon the coastal area and inland waters, including the vitally important nursery area.

The proponent has not given enough consideration to the impacts of the following:

- Introduced marine pest species;
- Generation of acid sulphate soils;
- Sediment and nutrient management of the area;
- Hydrological changes; and
- Impacts of the water intake pumps upon the juvenile prawn and fish species.

Furthermore, in the long term, the proposed facility will certainly lead to alteration of the creek, algal mat and mangrove systems due to the 70 km long retaining wall being built a mere 600 m inshore of this regionally significant ecosystem.

MG Kailis and other fisheries are totally dependent upon the nursery area and the clean waters of Exmouth Gulf. The prawn fishery is known to be dependent on juvenile recruitment from the shallow seagrass and algal beds on the eastern side of the gulf. The proposal to address bitterns handling/recovery and impacts until after the project has been assessed by the EPA is unacceptable since this likely constitutes the biggest environmental consequence of the project upon the nursery areas and clean waters of Exmouth Gulf.

Both commercial and recreational fisheries will potentially see a reduction in recruitment as a consequence of changes to habitat structure and foodwebs resulting from the construction of the 70 km long solar salt complex.

The proponent has tried to give falls impressions of its project through diverging media releases implying that prominent scientific institutions back the project (see Appendix G).

## 2.5 References

Department of Environment, 2006. Draft Identification and Investigation of Acid Sulphate Soils – Acid Sulphate Soils Guideline Series prepared by the Land & Water Quality Branch

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# 3 COMMERCIAL FISHING – PEARLING INDUSTRY

**www.wafic.org.au**


| | |
|---|---|
| Address: | Suite 6<br>41 Walters Drive<br>Osborne Park, WA 6017 |
| Telephone: | +61 08 9492 8888 |
| Fax: | +61 08 9244 2934 |
| Postal Address: | PO Box 55,<br>Mt Hawthorn, WA 6915 |
| Email address: | pearler@wafic.org.au |

## 3.1 Introduction

Pearling activities associated with Exmouth Gulf cover the range of operational stages found within the industry.

Exmouth Gulf is site of wild pearl oyster stocks which are subject to fishing as part of the management quotas.

Hatchery activities onshore produce pearl oyster spat which is settled on longlines and grown-out to seedable size in Exmouth Gulf. It is a 5 year timeline between spawning and seedable size for pearl oyster spat. The region is renown for spat production with several pearling companies in WA and the Northern Territory reliant on the spat from the Kailis hatchery for their round pearl culture pearl oyster supply. Several companies have established spat grow out sites within Exmouth Gulf given the unique conditions available for this important stage of the pearling operation.

Pearl oysters are also seeded in Exmouth Gulf when reaching maturation and are held on longlines during the important post operative stage (turning program) between May and October. After this period the pearl oysters are transported to pearl farms in cyclone impact mitigation regions at the Monte Bellos and the Kimberley.

The pearling industry depends on pristine water quality conditions with high nutrient value and the region between NW Cape and the WA/NT border (including Exmouth Gulf) produce the most conducive environment for producing the highest quality pearls in the world.

The value of Australian pearl production based on the Pinctada maxima pearl oyster species has varied between $120 and $175 million per year between 1995 and 2001.

The Western Australian industry, which equates to 95% of this value, has 17 pearling licences issued under the Pearling Act 1990. Each licence is fully transferable and has a quota attached for wild stock pearl oyster collection and a quota for the total oysters allowed to be seeded for the first time in any year made up from wild oysters and hatchery produced oysters.

Paspaley Pearls operates 5 licences in WA with a quota holding equating to 44% of total quota issued. Kailis is the second largest in WA with two licences and approximately 11% of quota. A full schedule of quota holders is attached.

Seeded pearl oysters are grown in mesh panels, attached to horizontal longlines with floatation buoys on the surface. The mesh panels containing oysters are attached to the longlines and suspended below the surface. The pearl oysters feed naturally through nutrient flow in tidal systems. No artificial feed is used in the pearling process.

The pearling industry employs in excess of 800 people in the region NW Cape to WA/NT border. The work is very focussed on manual handling to minimise stress to oysters.

Clearly, this industry is of considerable importance to Western Australia, and to the regional communities in Exmouth, Broome and the Kimberley in particular. The WA government listed the WA Pearl as one of the seven icons of WA during the 175th anniversary of founding of WA together with the Swan River and Rottnest.

## 3.2 Summary of Major Concerns

The following have been identified as threats to the pearling industry and are discussed in detail in Section 3.3:

- Introduction of marine pests;
- Nutrient content in water; and

- Pollution, including the management of bitterns and general waste disposal.

## 3.3 Response to Relevant ERMP Sections

### 3.3.1 Introduction of marine pests

The expected increase in marine international and domestic vessel traffic poses a high risk for the introduction of marine pests. Straits estimate 40-50 ships up to 100,000 tonnes will be loaded annually at 3,000,000 tonnes salt production and increasing to 120-150 ships at 10,000,000 tonnes salt production. Each ship loading requires a number of barge loads from the production site which will necessitate a large dredge to establish a barge channel from the new boat harbour.

From around the world and within Australia, there are many examples of Invasive Marine Species (IMS) being introduced and or translocated by a variety of vectors, including ballast water from international commercial shipping, biofouling on a wide range of vessels especially barges or dredges and natural vectors such as ocean current movements. Northern Pacific Seastar, Pacific oyster, European Fan Worm to name just a few. Specific threats to pearl oysters are the Asian Green Mussel and the Black Stripe Mussel which have the ability to wipe out the pearling industry if they take any hold due to the spectacular growth rates and smothering tendencies of substrate including pearl oysters.

The establishment of an IMS in a new environment can threaten biodiversity and aquatic health, as well as specific industries dependent on marine resources.

The pearling industry depends on pristine water quality conditions and the region between NW Cape and the WA/NT border (including Exmouth Gulf) produce the most conducive environment for producing the highest quality pearls in the world.

Large Panamax salt transport vessels and transfer/loading barges introduce the main vector for IMS translocation into Exmouth Gulf through ballast water and hull biofouling.

The presence of any IMS would trigger the Pearl Oyster Translocation Protocol with the likely result that all translocations would be prohibited until the risk for the spread of the IMS has subsided. This would have significant operational and financial implications for the pearling industry.

### 3.3.2 Nutrient content in water

The pearling industry depends on pristine water quality conditions with high nutrient value and the region between NW Cape and the WA/NT border (including Exmouth Gulf) produce the most conducive environment for producing the highest quality pearls in the world.

The proposed building of the 70km long sea wall and modification of landforms and creek flow will change the nutrient regime in the area. The proposal is for redirection of the natural run off through two creeks to either end side of the 70 km seawall which will decrease the nutrient content in the water and changes the salinity gradient in the middle of the wall. The redirection of the natural run off has been poorly considered in the ERMP.

Habitat modification will also occur for the inshore waters opposite the seawall and the inland areas of the Exmouth Gulf behind the seawall which are very important to fishing activities. The Straits Project is likely to alter existing habitat formats through redirection of important nutrients and the impact of bittern discharge or leakage.

The eastern side of Exmouth Gulf requires flooding events which move a significant way inland and experience evaporation and nutrients are then returned to the Gulf during the next flooding event. The seawall proposal will greatly impact the natural nutrient flow from this process and significantly alter hydrology and salinity within the mangrove community thus altering the drainage and sedimentation and reducing the flushing of mangroves. It is expected the soil water table will rise causing water logging of mangroves and possible death of mangroves situated above the intertidal zone as has happened in Port Hedland.

The significant dredging required for the boat harbour and barge channel may create changes in local drainage patterns, current directions and water circulation.

### 3.3.3 Pollution

Management of Bitterns

In information received under the logo of Straits Salt they estimate toxic waste production (bitterns) from salt generation at 20 billion litres per year at 10,000,000 tonnes production. This amount is significantly higher than any other salt producer in WA.

Straits Salt acknowledge they do not have sufficient technology available to them at this stage to responsibly manage the discharge of this waste so they have indicated that they will store the waste until satisfactory technology to handle such waste is developed.

Although bitterns would not need to be disposed of for many years until pond floors have been developed (5 to 10 years depending on final size), when the salt production is a full capacity, storage of bitterns will not be possible for beyond a few days and inability to discharge would cause operations to cease, which we is unlikely to happen. Once discharge starts taking place, this will then be continuously for much of the year for the rest of the life of the project.

It is not likely that the release of bitterns into Exmouth Gulf could ever be managed to achieve acceptable environmental outcomes. The volumes involved (in the order of 1000's of cubic meters per hour) make measures such as piping of the bitterns to deeper water (where it can more easily be mixed) non feasible.

The feasibility of 100% resource recovery of a significant proportion of the bitterns produced and re-use of bitterns is very unlikely and the commitment to undergo a later approvals process belies the dependence of the proposal on gaining that approval at a later date. If re-use / resource recovery was a feasible option, would other existing salt producers not have utilised this option? It is more likely that bittern recovery will depend on small nice markets and will not be a commercially viable solution. It is our opinion that the proponent has therefore failed to address the most difficult environmental issues it faces. This may be in the hope that once established, there will be additional social and economic leverage in support of the project.

This approach is totally irresponsible and, until satisfactory proposals for responsible management of the toxic waste or bitterns is established and discharge options carefully evaluated, the entire proposal to generate salt production should be rejected. If the project were to be approved with the condition that "No bitterns are to be discharged into the Gulf for the life of the project" - the project would probably become non-viable.

General Waste Disposal

Straits propose using a desalination plant which in itself creates liquid wastes that may contain high salt concentrations, chemicals used during defouling of plant and equipment and toxic metals. A small amount of solid waste is also produced from desalination plants.

Discharge options again need careful evaluation even if stored with bitterns waste for reasons outlines above.

Food wastes and human wastes must also not be disposed of in the ocean as this may risk local marine life.

Spoil from dredging and waste from construction of the seawall, jetty and roads also present problems if dumped or allowed to leach into the marine environment as it may alter current flows or increase turbidity of adjacent creeks and tidal areas.

## 3.4 Conclusion

The WA pearling industry is extremely concerned about the proposed development for a huge salt mining project on the eastern side of Exmouth Gulf.

The Straits Salt project is building a series of ponds with walls extending non stop for 70kms - the equivalent distance from Yanchep to Rockingham - expected to have a range of direct and indirect impacts on the natural environment and radically altering natural drainage and replenishment patterns that could starve much of the ecosystem of its vital natural resources.

Commercial pearl farms contributing up to $40 million in export income to WA operate within the area proximate to the land the subject of Straits' mining application.

Most importantly is the risk from introduction of non-native invasive marine species and the spread of diseases from ballast water discharge and the changes to water quality from waste discharge from salt production. Fully laden 70,000 tonne bulk transport ships will be in and out of Exmouth Gulf to export the salt overseas. Fifteen major marine pests have been identified in Australian waters through introduction from overseas.

Increase in boating traffic past the main pearl farm areas to transport salt from Hope point to a bulk transport vessel in the middle of the Gulf, will increase the risk of water pollution and introduction of marine pests which could affect the pearl production in the whole region.

Pearling operations rely on good quality marine water to produce the world class, highest quality pearls for which Australia is internationally recognised.

Straits Resources, has also failed to detail in the recently release ERMP how it will dispose of vast quantities of toxic bitterns that are the by-product of its proposed solar salt project. There is no information presented in Straits Resources ERMP concerning the amount of bitterns which will be generated at the 'nominal' salt mine production levels of 10 megatonnes of salt per annum however Straits bitterns estimated production in earlier documentation is 20 billion litres per annum.

The coastal and inshore eastern area of Exmouth Gulf is largely undeveloped and streams flowing into the Gulf are small and typically only flow following intensive rainfall around cyclone events. The position of the pond walls appears to physically redirect these streams putting natural flushing and distribution at risk.

The salt production facility will indirectly impact upon pearling operations by changing current water flows, salinity or nutrient availability. The pearling industry is concerned that the impacts may include changes to coastal nutrient runoff into Exmouth Gulf with negative impacts on important mangrove systems and increased turbidity which may in turn increase disturbance to the marine and coastal ecosystems.

The presence of any introduced marine pests would trigger a response under the Pearl Oyster Translocation Protocol with the likely result that all transfers of pearl oysters to operational locations around the Pilbara/Kimberley coast would be prohibited until the risk for spread of marine pests has subsided.

**Attachment 1 -**

## Pearling Licence & Quota Holders in Western Australia

As at December 2006

| COMPANY NAME | Combined Wild & Hatchery Quota Units |
|---|---|
| **Pearling Licence & Quota Holders** | |
| Arrow Pearls | 15 |
| Australian Sea Pearls | 70 |
| Blue Seas Pearling | 45 |
| Blue Seas Pearling (Administration) | 30 |
| Clipper Pearls | 37 |
| Cygnet Bay Pearls | 75 |
| Dampier Pearls | 35 |
| Exmouth Pearls | 35 |
| Fantome Pearls | 45 |
| Hamaguchi Pearls | 35 |
| Maxima Pearls | 35 |
| Morgan & Co | 65 |
| NorWest Pearls | 35 |
| Paspaley Pearls | 120 |
| Pearls Pty. Ltd. | 100 |
| Roebuck Pearl Producers | 75 |
| The Australian South Sea Pearl Company | 70 |
| **TOTAL** | **922** |

# 4 RECREATIONAL FISHING

**www.recfishwest.org.au**

| | |
|---|---|
| Address: | Watermans Bay Marine Centre<br>West Coast Drive<br>Waterman WA 6020 |
| Telephone: | +61 08 9246 3366 |
| Fax: | +61 08 9246 5955 |
| Postal Address: | PO Box 34<br>NORTH BEACH WA 6920 |
| Email address: | recfish@recfishwest.org.au |

## 4.1 Introduction

Recfishwest is the peak body representing the interests of the estimated 788,000 (pg. 106, Department of Fisheries, Annual Report to Parliament 2005/06) recreational fishers in Western Australia. We are formally recognised by the Government in this role. Recfishwest places the highest priority on safeguarding the future of recreational fishing and the resource it depends on in Western Australia.

Exmouth Gulf is world renowned for its fantastic fishing with its fish rich shallow water, mangrove lined creek systems and numerous shoals and scatted reefs. The Eastern side of the Exmouth Gulf is one of the few remaining remote and pristine locations, attracting dedicated sports fishers because of its wilderness appeal.

The area is attractive to sportfishers due to the difficulty of access for various reasons including the long distance from roads and launching facilities. Access is limited by weather as it is exposed to frequent strong southerly winds.

The diversity of the Exmouth Gulf provides unique opportunities for recreational fishers. Within the Gulf there are many islands, shallow flats and reef that hold an array of different species and fishing opportunities. On the eastern side of the gulf are an abundance of pristine mangrove creeks that hold prized recreational sportfish such as barramundi, mangrove jack, giant herring and queenfish. The intertidal systems of the Gulf contain numerous important recreationally targeted species including trevally species, flathead, whiting and mud crabs. The deeper waters of the Gulf harbour prized demersal species such as coral trout, red emperor, blue-bone, north-west snapper as well as multiple species of rock lobsters. All of these species depend to some degree on juvenile recruitment from the eastern gulf.

The pelagic sports fishing opportunities of the Gulf are world renowned. Sailfish are plentiful in late spring as they feed on the tonnes of baitfish that congregate in the Gulf. Juvenile marlins have also been regularly encountered right up in the shallows.

The wilderness nature of Exmouth Gulf is appealing to the recreational anglers that fish the area and the eastern Exmouth gulf has been identified as a potential wilderness fishing area, to preserve that unique experience.

## 4.2 Summary of Major Concerns

Recfishwest has identified the following points as potential threats to recreational fishing in the Exmouth Gulf region;

- Impacts on recreational fish species from the modification / loss of nursery areas;
- Impacts on recreational fish species from water intake pumps particularly the entrapment of larval and juvenile finfish and crustaceans;
- Impacts on recreational fish species from potential future disposal of bitterns and/or the accidental release of bitterns through storm/cyclonic events;
- Impacts upon recreational fishing from changes in marine and sediment quality;
- Impact on wilderness fishing experience following the development of this proposal.

Other concerns that Recfishwest has with the proposal are:

- Introduced marine pests and diseases from increased shipping activities due to the development;
- Impacts from barge harbour dredging / acid sulphate soils.

- Impacts from alteration of surface water flows in terms of lost of productivity of ecosystem and fisheries related by diversion of fresh-water runoff containing nutrients in heavy rainfall events;

  These concerns have been extensively covered in the submissions of the other alliance members and will therefore not further be described.

## 4.3 Response to Relevant ERMP Sections

### 4.3.1 Impacts from the modification / loss of nursery areas

Exmouth Gulf forms an important nursery area for valuable commercial and recreational fish species. We believe that the Yannarie mangrove system on the eastern side of Exmouth Gulf is a vital nursery area for many forms of marine life including finfish and crustaceans. Many species using this area as a nursery are highly valued by recreational fishers. There are very few areas of mangrove systems and the loss of an entire system could have ecosystem scale impacts.

Recreational fisheries are highly dependent on the maintenance of high water quality and the natural ecological processes which drive marine productivity. We believe that the Yannarie Salt Project proposal poses a significant threat to this unique area. We are concerned that the construction of the solar salt proposal could potentially see a reduction in finfish and crustacean recruitment through habitat structure changes and changes to foodwebs to a much wider area to which adults would take up residence. We are also concerned by the enormous numbers of larvae and juveniles will also be directly removed from the nursery habitat through the water intake pumps.

### 4.3.2 Impact on wilderness fishing experience following the development of this proposal

Recfishwest questions the mitigation measure of allowing recreational fishing access to the first concentrator ponds as a compromise for the potential destruction of fish nursery habitat as a result of the proposed salt production facility.

We believe that the promotion of access to the first concentration pond as incentive for recreational fishers support should be viewed with scepticism. Existing solar salt projects in Western Australia have gone down that path and at this time all prohibit access for recreational fishers within their mining lease citing occupational health and safety requirements.

### 4.3.3 Impacts from potential future disposal of bitterns and/or the accidental release of bitterns through storm/cyclonic events

The impounding of large quantities of toxic bitterns presents an unacceptable risk to this sensitive environment. Straits Resources have made no assurances in the ERMP that the bitterns resource recovery strategy will be adopted, rather stating that a feasibility study will be carried out.

It is stated that a final assessment of the technical and economic options for resource recovery from the bitterns will be completed within ten years of the commissioning of Stage 1. We believe bitterns discharge should have been assessed in the current ERMP. Waiting until the project is fully operational before applying to discharge bitterns is unacceptable. Any release of bitterns into Exmouth Gulf could be catastrophic for the marine environment particularly in terms of the quantity that will be potentially will be stored by this proposal.

The impoundment of bitterns is not without risk. Potential seepage or wall failure as result of extreme weather events such as cyclones and storms are realistic threats to the

proposed solar salt mine. The escape of toxic bitterns into Exmouth Gulf could potentially kill vast numbers of marine species.

We believe that the ERMP does not adequately address contingency measures for storing bitterns in the event of natural disasters such as cyclones.

### 4.3.4 Impacts from changes in marine and sediment quality

The eastern shoreline of Exmouth Gulf is one of the largest embayments on the Western Australian coast and its extensive sand flats, seagrass meadows and mangrove lined tidal creeks function as highly productive nursery areas. These habitats function as important nursery grounds for finfish and crustaceans important to recreational and commercial fisheries. The pumping of large quantities of sea water is likely to modify salinity and/or flow in the Gulf, which could have significant consequences for primary productivity and hence recruitment of finfish and crustaceans important to the recreational fishing sector.

### 4.3.5 Introduced marine pests and diseases from increased shipping activities due to the development

It is estimated that at peak production 150 bulk carriers will visit the Gulf each year to export salt. The impact of dredging and intake channels to facilitate these large ships could give rise to increased turbidity resulting in shading or smothering of benthic primary producers thereby affecting water quality. Dredging may lead to the destruction of natural habitat.

International shipping also opens up the threat of translocation of exotic marine pests from high-risk regions. An outbreak of a marine pest species has the potential to cripple many commercial and recreational fisheries in the region.

The increase in large ship traffic also posses a safety threat in terms of visibility of the small recreational fishing craft (invariably four to five metres in length) that frequently use the Gulf.

## 4.4 Conclusion

Recfishwest believes the risks posed by the proposed salt mine are too large considering the environmental and financial values of the area. The importance of Exmouth Gulf as a nursery habitat for many valued recreational finfish and crustacean species should not be compromised by the development of a solar salt mine. We believe that the important environmental concerns such as the storage of bitterns and their potential discharge in the future are inadequately addressed in the ERMP.

# 5 COASTAL CONSERVATION


**www.conservationwa.asn.au**

| | |
|---|---|
| Address: | City West Lotteries House<br>2 Delhi Street<br>West Perth, WA 6005 |
| Telephone: | +61 08 9420 7266 |
| Fax: | +61 08 9420 7273 |

## 5.1 Introduction - The Significance of Eastern Exmouth Gulf

The tidally-controlled southern and eastern sectors of Exmouth Gulf including the Yannarie wetland system have long been recognised as ecologically significant environments. The contiguous mangle fringing the eastern shore is the most extensive stand in the remarkable arid zone system of the Pilbara region and the only section lying in the sub-tropics (Semeniuk 1999, EPA 2001). It may well be that the mangle of the Yannarie wetland system is the largest, contiguous stand outside the wet tropics although this is difficult to confirm internationally.

The area including the extensive banks and shallows seaward of the mangle has long been closed to commercial fishing in recognition of its importance as a nursery for marine life, including many fish species and the prawn resources for the Exmouth Gulf trawl fishery. A progression of this level of protection to a Fish Habitat Protection Area was proposed by the Department of Fisheries in its Gascoyne Environmental Review (Shaw 2002).

The Marine Parks & Reserves Selection Working Group (MPRSWG, 1994) recommended that a marine reserve be established over the area, including the eastern waters of the Gulf and incorporating the wetland system including supra-tidal mudflats (i.e. the location of the proposed solar salt complex).

The State Government's World Heritage Consultative Committee for the North West Cape Range-Ningaloo Area preferred boundaries included all of Exmouth Gulf incorporating the Yannarie wetland system including the supra-tidal mudflats. The entire area was considered to meet World Heritage criteria for 'biological evolution' and 'biological diversity' and parts of the area for 'superlative beauty' and 'geo-evolutionary history'. The inclusion of the area was also considered necessary to meet World Heritage requirements for system integrity (World Heritage Consultative Committee 2004).

There is a clear case for the Yannarie River Delta including delta plain, supra-tidal flats and the intertidal algal mat, mangle and mudflat systems to be recognised internationally as a geoheritage site (Appendix C).

The marine waters of eastern Exmouth Gulf have been assigned the maximum level of environmental protection for ecosystem health under the interim Pilbara water quality policy. This level requires "no contaminants (pristine, no change from background conditions) and no detectable change from natural variation of biological indicators". The application of such criteria clearly prohibits the discharge of brine, bitterns or any other substances into the eastern Gulf.

## 5.2 Summary of Major Concerns

The following concerns for the conservation of the area have been identified and are discussed in detail in Section 5.3:

- Proponents responses to the conservation significance of the area;
- Impacts on the Yannarie wetland system;
- Impacts on Exmouth Gulf in relation to surface hydrology & terrigenous inputs, sources of productivity in Exmouth Gulf and potential changes in salinity;
- Impacts on marine wildlife (dugongs, sea turtles, humpback whales and migratory shorebirds); and
- Decommissioning.

## 5.3 Response to Relevant ERMP Sections

### 5.3.1 Proponents responses to the conservation significance of the area

There would appear on the face of it to no acceptable basis in terms of government policy for a solar salt project to be considered in this area. It is something of an indictment of the current government's approach to sustainability that this proponent has even been allowed to progress the proposal to this stage, especially given the heavy ongoing cost to business and community respondents.

The proponent has set out strategically to circumvent previous government recommendations, guidance statements and policy positions in a number of ways.

1) By claiming (erroneously - see Appendix C) that the partial, physical avoidance of the algal mats and mangroves by the salt pond footprint will prevent significant impacts on these habitats and therefore comply with EPA Guidance Statement 1;

2) By contesting the inclusion of the supra-tidal flats in the marine reserve and other conservation proposals by asserting (erroneously - see Appendices B, C and D) that there are no significant hydrological / ecological connections between this feature and the inter-tidal and marine habitats of the eastern Gulf (**the vacant ecosystem hypothesis**);

3) By misrepresenting the reasons for the eastern Gulf not being included in the State's World Heritage proposal.

   Exmouth Gulf qualified in some way under all four of the natural values criteria. It was not included, along with other areas recommended by the Committee, because the then federal Minister for the Environment chose to support the interests of the pastoral industry and indicated to the State government that he would not progress the Committees preferred boundaries with the UN. The omission of the Gulf from the proposal was for political not technical reasons. This may well see the nomination fail at the World Heritage Committee because it now fails to meet the test for ecosystem integrity; and

4) By claiming that bitterns stored in concentrator ponds will have an economic use and market within 10 years.

   Our existing solar salt operations have explored the economic utilization of bitterns as an alternative to harmful discharge. The technologies and markets have hitherto not developed and it is highly unlikely that they will in the next ten years. It appears the proposed land-based storage of bitterns is a ploy to achieve project approval. The proponents may be banking on the probability that in a decade, with the toxic legacy accumulating, the State Government will have no option but to compromise the community's water quality objective and allow bitterns discharge.

   The proponent's erroneous assessment of the stratigraphy and groundwater hydrology of the site further increases the long-term ecological risks of bittern storage within the salt field.

### 5.3.2 Impacts on the Yannarie Wetland system

The Straits Solar proponents claim that the impact on the wetland habitats of the eastern Gulf will be restricted to the direct removal or burial of 5.4 ha of mangroves and 31 hectares of algal mat. We will leave to the EPA to decide whether that can be accommodated under Guidance Statement No 1.

In our view however the longer term seepage from the salt bonds will cause irreparable damage to the producers in the inter-tidal zone over much of the area. Semeniuk

(Appendix C) came to the following conclusion based on his first hand knowledge of the stratigraphy of the delta:

"*The development of a super-saline water body in the evaporation ponds, with a relatively high hydraulic head, will result in seepage plumes of dense saline water into the underlying sediments, which will discharge seawards emerging from under the tidal flats. East Exmouth Gulf will provide the first location in tropical Western Australia where a continuous fringe of mangroves will intersect the super-saline water discharge (essentially an effluent) from proposed solar salt ponds and where there also is an inherent natural stratigraphy that will result in the delivery of the anthropogenically formed saline plume (the effluent) to the tidal flats and their biota. This discharge will fundamentally alter the ecosystem of the tidal flats, from a microbial perspective, and from macrobiota such as invertebrate fauna and mangroves*".

The very limited (hand-auger?) core sampling of the materials underlying the supra-tidal flat was undertaken without any understanding of the stratigraphy of the shoreline resulting from a progression of sea levels. Bands of coarse, sandy sediment may be found in each sequence and these bands will conduct groundwater seaward relatively rapidly. The proponents have also ignored the presence of karst features within the proposed pond system, even though this outcrops obviously at Hope Point and on the near-shore islands. They have also missed that the pro-grading shoreline would have been vegetated potentially leaving root canals and other conduits (see Appendix B).

The loss of algal mats, to the hyper-saline halo that would probably develop at various points along the seawall, would reduce the supply of nitrogen and carbon to the mangle and to a host of inter-tidal consumer organisms (Paling & McComb 1994). The loss of mangle would not only reduce the productivity of the inshore (tidal creek) environments but would remove the critical structure of the marine nursery. The populations of mangrove specialist passerines and bats in the region would be decimated.

The outcomes from miscalculating the potential for the lateral movement of hyper-saline groundwater are likely to be catastrophic and there is a high probability that the proponents have got it wrong. The consequences of the escape of stored bitterns material via the groundwater system are likely to be extremely acute since these would not only be extremely concentrated in salts (osmolalities of 11000 mosm/kg of water versus 400 in sea turtles –Tovar 2002) but would contain high concentrations of bio-accumulants including heavy metals and selenium and toxic concentrations of fluoride (e.g. 60.5 times seawater – Tovar 2002).

Significant sea level rise is inevitable during the current century due to anthropogenic changes to the levels of greenhouse gases in the atmosphere. The most recent and authoritative estimates of change were provided in 2006 and range from 280 to 1400 mm. The estimates used by the proponent, and adopted by DPI in 2003, are out of date and not precautionary with respect to more recent predictions (see Appendix B).

In any event the Bruun model and rule were never applicable to muddy shorelines (Bruun 1983). The model has never been validated and recent studies indicate that even for sandy shorelines (where it was intended to apply) it as little predictive value (Cooper & Orrin 2004). The model ignores the enormous local variations in sediment cell behaviour (Cooper & Orrin 2004) and inter-annual and longer variations in ocean climate (Meyers et al. 2003 and 2004). The proponent's analysis with respect to the environmental impacts of their positioning of the seawall barrier would appear to be flawed.

As sea-levels rise the algal mats and mangle may be able to retreat landward into what is currently the supra-tidal flat. One would expect an intermediate sea-level change of around 0.5 metres would drive significant changes in the tidal distribution of algal mats and mangrove species. However the presence of an uninterrupted 70 km seawall would prevent such a redistribution occurring. Should any mangrove habitat ultimately survive

the chronic impacts of increasing groundwater salinity from brine and bitterns seepage it may ultimately be lost to changes in sea level.

### 5.3.3 Impacts on Exmouth Gulf

The concentrator pond complex proposed would occupy the supra-tidal flats behind the mangle over most of the spatial extent of the Yannarie wetland system. All potential connection through surface hydrology, between the tidal distributaries and the Gulf, and the eastern catchment would be severed by a 70km long seawall. Floodwater discharges would be focussed through diversion channels at the northern and southern ends of the complex.

According to the Australian Institute of Marine Science Exmouth Gulf is the most productive natural embayment yet studied in Australian waters. However phytoplankton abundance is low compared to the biomass of grazing zooplankton (McKinnon and Ayukai 1996), suggesting that the Gulf must receive carbon and nitrogen subsidies from non-oceanic sources or from pulses of nutrients (e.g. from upwellings or floods). The ERMP suggests that nitrogen and carbon fixed by the algal mats drive the productivity of Exmouth Gulf and that flood-out events through the Yannarie Delta would occur too infrequently to be ecologically significant. The proponents also suggest that the focussed discharge of floodwaters to the central Gulf would have the same effect as the sheet flow through the myriad of mangrove lined, distributary channels and across the shallow sediment banks vegetated with macro-algae and seagrasses. The respondents find this position implausible and suggest that the benthic producers of the eastern Gulf are likely to be very important for the retention and re-supply of nutrients to the system. Focal discharges to the deeper waters of the Gulf are likely to see nutrients lost from the system.

Surface Hydrology & Terrigenous Inputs

The proponents have excluded the catchment and terrigenous inputs as a significant contributor to the productivity of Exmouth Gulf based largely on their modelling of surface hydrology. They concluded that rainfall and storm surge events sufficient to generate a hydrological connection between the Gulf and the catchment across the supra-tidal flat had a return period of 20 years. Long-term local experience suggests otherwise. The only space photography following a cyclone passage (Cyclone Bobby 1995) available clearly shows complete sheet flow across the supra-tidal flats discharging to the Gulf through all the mangrove line distributary channels. The physical evidence does not validate the modelling. The presence of fresh terrigenous sediment and chemical markers for terrestrial vegetation (glomalin) in the mangroves (Dr Catherine Lovelock, Exmouth Gulf Forum) also suggests that the models predictive capacity, at least in this context, is unacceptable.

Walker (Appendix B) found that the steps in the modelling process were impossible to track, the rainfall inputs were inappropriate and out of date and various parameters utilised were not justified. Such models are very poor at predicting infrequent, aperiodic events. It would be interesting to see if modelling of the Cyclone Bobby storm event would have predicted the observed hydrological connection between the eastern Gulf and its catchment. Unfortunately the respondents did not have access to the model used to test it.

Sources of Productivity in Exmouth Gulf

At the scoping document stage the proponent was suggesting that a recently discovered up-welling feature off North West Cape may subsidize the nutrient pool in Exmouth Gulf and be the source of its estuarine productivity. Latterly, in the ERMP, it is suggested that the nitrogen-fixing mats of cyanobacteria in the spring tidal area behind the mangle may account for much of this productivity.

Exmouth Gulf is for most of the time a reverse estuary with elevated salinities in the shallow, tidally controlled waters along the eastern and southern shores. It probably however functions as an arid zone estuary, receiving sediment and nutrients from its catchments, during infrequent, aperiodic flood-out events. The proponents have ruled out terrigenous inputs to productivity as such sources would be blocked by the 70km long solar salt pond complex (they might constitute an inconvenient truth!).

In November 2005 the Halt the Salt (HtS) campaign organised a snapshot stable-isotope survey of Exmouth Gulf to examine the macro-scale structure of its food chains and the potential sources of nitrogen (see Appendix D). This brief investigation made the following conclusions:

- Representative groups of consumers in Exmouth Gulf were deriving their energy primarily from macro-algae and to a lesser extent seagrasses;
- These producers were obtaining most of their nitrogen from recycled, organic forms (e.g. ammonia);
- The spring - tidal microbial mat material was not contributing carbon or nitrogen directly to the open water consumers of the Gulf;
- Oceanic sources of nitrate nitrogen were probably contributing to the phytoplankton biomass of the Gulf waters but not directly to the estuarine food-chain;
- For much of the time the production in the Gulf appears to be based on recycling of nutrients. However it seems probable that the nutrient pool would have to be recharged at some stage. The potential importance of infrequent, aperiodic terrigenous inputs cannot be discounted with our current level of knowledge; and
- Repeating the stable isotope survey with a few months of a flood-out event may be useful in testing for intermittent terrigenous nutrient subsidies.

The only longitudinal study primary production available for the Gulf comes from the monitoring of seagrass regeneration since Cyclone Vance in 1999, initially by CSIRO and since 2003 by Department of Fisheries staff (see Appendix E). Cyclone Vance was an extreme (category 5) event that passed through the centre of the Gulf, stripping sediment from the deeper waters and depositing it in the inter-tidal and shallows. Much of the mangle, seagrass and macro-algae cover of the eastern Gulf was smothered. It may therefore not be a good model for other cycles triggered by cyclones.

Seagrasses all but disappeared from the floor of eastern Exmouth Gulf after Cyclone Vance. In subsequent years the cover increased rapidly peaking in 2003 due primarily to the biomass of *Halophila spinulosa* which appears to be a disturbance opportunist. Since that time other seagrasses previously recorded as the more abundant species in Exmouth Gulf re-established, these included *Halodule uninervis*, *Cymodocea serrulata* and *Syringodium isoetifolium*. At most study sites the biomass / cover of seagrasses and algae declined sharply between 2003 and 2005 and remained low in 2006. This suggests that there is a seagrass regeneration cycle, triggered by cyclone or other storm events. The regeneration of colonizing species, and then longer lived species, may be driven by a pulse of nutrients supplied by the storm event. Some of these may be mobilized from the disturbed sediments but terrigenous inputs are also probable. The decline in seagrass / algae biomass 4-5 years after the cyclone suggest that such events, with a return period of less than a decade, may be important in maintaining the productivity of the Gulf.

Overall the conceptual model of Exmouth Gulf (the battery model) is one of a system where productivity is controlled by a nutrient pool. This pool appears to require infrequent nutrient recharge from flows associated with storm events and in all probability including a terrigenous subsidy from the catchment (i.e. eastern Exmouth Gulf is an arid zone estuary).

Potential Changes in Salinity

Exmouth Gulf is a reverse estuary with elevated salinities of up to 40 ppt in the shallow near-shore waters along the eastern and southern coasts. The higher salinity zones appear to be an important feature of the prawn and fish nursery, presumably because they are something of an osmoregulatory barrier to larger predatory fish. This salinity regime is maintained by the high evaporation the shallows, inter-tidal and supra-tidal flats. Periodic flooding of the super-tidal (algal mats area), during spring tides, and supra-tidal, during storm surges, would presumably return stored salt to the Gulf.

The solar salt complex could alter the salinity regime of the nursery in several ways. These include:

1. The predicted seepage of brine from numerous points along the seawall;
2. The extraction of large quantities of high salinity water from the eastern Gulf waters by the pumping and its replacement with lower salinity oceanic water; and
3. The isolation of the supra-tidal salt store from storm surges by the 70 km seawall.

The long-term consequences of these potential alterations to the salinity balance were not considered in the ERMP and the impacts have not been assessed.

### 5.3.4 Impacts on marine wildlife

The protected species of the Gulf would be impacted by the broad threats posed by the project to the Yannarie Wetland System and the marine ecosystem of the Gulf as discussed in the preceding sections. Other, more direct, impacts on wildlife can also be identified.

Dugongs

The seagrass cover that develops on the inter-tidal and sub-tidal sediment banks on the eastern side of Exmouth Gulf, particularly south of Simpson Island, are known to be an important foraging habitat for Dugong. These animals are part of west coast population that occupies Shark Bay, Exmouth Gulf and the Pilbara coast. Segments of the population (at least) are highly mobile, responding to losses and gains of foraging grounds entrained by the impact of tropical cyclones (Bob Prince, HtS Forum).

During periods of food shortage (e.g. after Cyclone Vance in Exmouth Gulf) the Dugongs may concentrate on the remaining “pastures” particularly in Shark Bay. There appears then to be a density dependent reduction in the birth-rate that may ultimately influence overall population size. Put another way the condition and extent of the seagrass cover in Exmouth Gulf may have an impact on the size of the dugong population as a whole.

The dredging impacts (habitat removal and smothering) associated with establishing and maintaining the barge channels for the project will remove seagrass habitat from the banks, at least in the important Hope Point area.

Previous modelling of dredging impacts in WA has proved to be unreliable (e.g. Geraldton Port) and there is no particular reason why respondent’s should take the results presented in this ERMP as credible. But even if one accepts the stated magnitude

and duration of seagrass loss there would appear to be the potential for a reduction in the Dugong population size. The data presented on impacts to Dugongs in the ERMP is adequate given the risk to a discrete population highly threatened marine mammal. Dugongs are also very vulnerable to boat strike and the presence of a barge route across an important feeding ground will probably lead to ongoing collision mortality.

Sea Turtles

The eastern side of Exmouth Gulf is an important foraging ground for Green Turtles including for adult females breeding on the Islands of the North West Shelf (e.g. Barrow Island, Bob Prince pers. comm.). The adults are mostly observed feeding on macro-algae and seagrass on the banks. The more carnivorous juveniles are common within the mangle and along the tidal creeks. Adult foraging habitat will be lost to dredging and associated smothering of the bank habitats. The impact of this on provisioning, pre-laying females is unknown.

Humpback Whales

Exmouth Gulf is an important rest area for Humpback Whales on their southward migration, presumably because it provides sheltered water for the calves. Communication between animals is likely to be very important in maintaining social relationships at this stage in the migration.

If this project proceeds there will be continuous shifts of barges loading up to three Panamax Carriers at the anchorage in the central Gulf. This location is itself an important staging area for Cows and calves. Curt Jenner (HtS forum) indicated that such operations would generate significant underwater noise and at least some displacement. The consequences of this on Humpback Whale behaviour and calf survivorship were unknown would take at least 5 years (prior to operations commencing) to determine. Collisions between barges and whales could also be an issue.

A similar arid zone solar salt project in Baja California had been stopped primarily because of projected impacts on Gray Whales.

Migratory Shorebirds

The eastern side of Exmouth Gulf is currently used by a high diversity of migratory shorebirds but the numbers are relatively low (except for Grey-tailed Tattler) compared to the Pilbara coast and Lake Macleod. This was attributed to a lack of secure, open high tide roost sites. The salt pond complex will probably provide the habitat image of such roost sites and the lower salinity ponds will provide feeding habitat for surface picking and swimming / sieving shorebirds that will make use of Artemia. The proponents make much of these “new” habitats for shorebirds as an environmental selling point.

Supplementary feeding habitats will probably do little to increase migratory shorebird populations as these are determined by factors on their northern hemisphere breeding grounds and at diminishing staging areas on the Asian flyway. They may however divert shorebirds from established feeding areas such as Lake McCleod (a far more significant, self sustaining shorebird habitat).

There would also appear to be a significant risk to shorebirds and terns attracted to potential roosting habitats amongst these concentrator ponds. Unlike the other solar salt fields these will include vast areas of bitterns storage ponds, containing highly toxic (high specific gravity fluids). Birds alighting on this medium are likely to be caked with adhesive bittern fluids that bind the feathers of stick to the legs. This material could have the

physical effect of binding the feathers and preventing flight. Bitterns is also highly toxic (e.g. to marine vertebrates such as Green Turtles – Tovar et al. 2002) and the shorebirds may die as the result of ingestion during preening. The bittern storage ponds may constitute a significant hazard to migratory shorebirds attracted to the concentrator complex. This risk was not identified in the ERMP and has not been assessed.

### 5.3.5 Decommissioning

This project is based on the production of very high tonnages of a low value commodity. The huge scale of the project is evidently necessary for it to be economically viable. The projected market is dependent on a long term continuation of the Chinese economic bubble and the ongoing sustainability of petrochemical industries dependent on petroleum consumption. Should Chinese growth moderate it is likely that the Straits Salt project would come into direct competition with other WA salt producers perhaps leading to closures.

The Yannarie Salt project if implemented would be vulnerable to economic and / or environmental failure at anytime. The cost of appropriate remediation would be enormous at least of the order of half a billion dollars. In the event of business collapse due to environmental failure the costs of remediation will fall on the taxpayer, as the project will have been approved by the State. In the event of business collapse due to economic failure the costs would only fall on the developer to the extent of any bond required by the government. It is hard to imagine any bond large enough to properly remediate and remediate 411 $km^2$ of concentrator ponds and other infrastructure.

No decommissioning plan (including a costing) has been prepared as part of the ERMP. The so-called 'Preliminary Closure Management Plan' ignores the most significant environmental issue. This is the remediation of many metres of brine (and in this case highly toxic bitterns) saturating the soil profile and groundwater beneath the pond complex. Remediation of solar salt ponds to allow for subsequent land-uses, or to protect the environment from long term emissions, is extremely difficult if not impossible (see Appendix B). In situations where it has been attempted budgets in excess of US $250m have left the task incomplete (Cargill North & South Bay City State USA).

Solar salt pond remediation has only been attempted in situations where the concentrator pond system was built substantially in the inter-tidal and a phased resumption of tidal flushing is possible. The concentrator system proposed for this project will be built in the supra-tidal where flushing and wetland habitat construction and maintenance are much more problematic. Interestingly the Port Hedland solar salt fields now support most of the wintering habitat for the eastern population of the Broad-billed Sandpiper. It will be interesting to see how the decommissioning of these 'pump-maintained' habitats would be managed in the event of closure. Attracting migratory shorebirds to solar salt project may carry with it perpetual long-term conservation responsibilities.

### 5.3.6 Aesthetic Impacts

Exmouth and Cape Range, in association with Ningaloo Reef, are becoming focal nature-based tourism assets for the State of Western Australia. Panamax bulk carriers and loading barges will be clearly visible at sea-level from Exmouth and intrude on the vista of Exmouth Gulf from lookouts in Cape Range National Park. Lights from the vessels will be evident at night. The salt concentrator complex itself may be visible from the top of Cape Range. These aesthetic impacts will change the perception of the region from one of an unspoilt wilderness environment to an industrial port. The resulting negative perceptions are likely to harm the planned development of the area as a core tourism asset.

## 5.4 Conclusion

- The eastern side of Exmouth Gulf, including the supra-tidal flats, has been identified as an environmentally significant area warranting special conservation measures by a range of agencies / planning committees.
- The proponent has attempted to downplay and misrepresent the significance of the area and the potential impacts of the project. To do this the proponent has promulgated a "vacant ecosystem hypothesis" for the supra-tidal flats.
- The proponent's proposal to store bitterns for the first 10 years until the material can be fully processed and marketed is holding position aimed at obtaining environmental report. It is evident, even from the content of the CSIRO consultancy, that the proponent will be seeking approval to discharge bitterns as soon as the storage capacity within the concentrator field is reached.
- The proponent has not acknowledged the significance of the Yannarie Wetland System (including the supra-tidal flats) as geoheritage.
- The proponent has not understood the stratigraphy of the supra-tidal flat leading to fatal flaws in understanding the hydrology. Contrary to the proponents assertions seepage of brine and bitterns from the concentrators is likely to destroy significant areas of algal mat and mangal and contaminate the waters of the Gulf.
- The proponent has not taken a precautionary design approach to sea-level rise and ignored the impact of the seawall in preventing the redistribution of the algal mats and mangroves in response to changes in sea-level of between 35 and 140 cm this century.
- The use of the Bruun Rule for muddy shorelines is invalid and meaningless.
- The concentrator complex is located over a variety of potential conduits of brine to the ocean and to deeper karst aquifers (one or regional water supply significance).
- The concentrator complex is so vast that it could potentially change local climate and cause coastal subsidence.
- The proponent claims that there is no hydrological connection between the catchment east of the Gulf and the Gulf waters based on flawed modelling of surface hydrology. Other evidence, including space photography during Cyclone Bobby indicates that this is not the case.

## 5.5 References

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# Appendix A

CSIRO Report

The Exmouth Gulf Prawn Fishery: Threats from a proposed mineral salt project.

By: Kenyon R.A. & Loneragan, N.R. 2004

# Appendix B

Salt Field Effects on the Hydrogeology of Shore & Marine Ecosystems

By: Walker, C. 2007

# Appendix C

Landform and Sedimentology -
Critical review of the ERMP on the Yannerie Solar Salt Project, eastern Exmouth Gulf

By: Semeniuk, V. 2007

# Appendix D

A Stable Isotope Snapshot of Exmouth Gulf Ecosystems -
An Interim Report for M.G. Kailis

By: Dunlop, N. 2007

# Appendix E

Seagrass Monitoring -
Exmouth Gulf March 2005 and 2006

By: Kangas, M. et. al. 2007

# Appendix F

Summary of Presentation to Workshop on ERMP for Proposed Straits Salt Development – Eastern Exmouth Gulf

By: Penn, J.W. 2007

# Appendix G

AIMS letter with regards to media release issued by Straits Salt regarding the Yannarie Solar project